

## **Geochemical anomalies in soil and high He above deeply buried Millennium and Phoenix Uranium Deposits Athabasca Basin, Saskatchewan**

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### Abstract

The Cameco's Millennium deposit occurs along the Marker fault in the basement rocks at ~ 750m depth and contains resources 68.2 million lbs (indicated) and 22.3 million lbs (inferred) U<sub>3</sub>O<sub>8</sub>. 137 soil samples were collected along three transects (503, 333 and 515 m long) over the deposit and they yielded anomalous values of U ( $\leq 1.1$  ppm), Pb ( $\leq 35$  ppm) and Cu ( $\leq 21$  ppm) after aqua regia digestion of humus and U ( $\leq 256$  ppb), Pb ( $\leq 2122$  ppb) and Cu ( $\leq 220$  ppm) after ammonia acetate leach of B-horizon soil. Most anomalies were directly above the deposit and surface traces of major faults, including the Marker fault. Gas samples (n=6 in 2012 and n=15 in 2013) were collected in monitoring wells and cemented exploration drill holes covering the area of 0.5 – 1 km. Almost all samples show high values of  $4\text{He}/36\text{Ar}$  relative to the atmospheric ratio. The highest value of 715 was recorded at 50 m depth in CX 52 in 2012, which intersected the mineralization.

The Denison Mine's Phoenix deposits occur along the unconformity between the crystalline basement and Athabasca sandstones and along shear deformation zones below the unconformity at ~ 400 m depth. They have resources of 52.3 million lbs (indicated) and 7.6 million lbs (inferred) U<sub>3</sub>O<sub>8</sub>. Sampling in 2011 and 2012 found anomalous concentrations of U ( $<17$  ppm) and Cu ( $<27$  ppm) in humus over the deposits. Dense sampling was conducted at the site in 2012 and also 2013 at the site that yielded high U values in 2011 and it reproduced anomalous values.

Our study confirms the reproducibility of soil geochemical anomalies and an upward migration of metals along faults, and demonstrates the dispersion of  $4\text{He}$  to the surface from U deposits. The results suggest surficial geochemical exploration is a reliable and efficient tool in detecting deeply buried uranium deposits.